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Ionospheric Induction of Earthquakes: Fitting the Data

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This discussion assumes that there are ionospheric anomalies in total electron count (TEC) as precursors to major earthquakes. Very careful work by Thomas et al. (2017) and others remove TEC anomalies when correlated with natural events such as geomagnetic or solar activity. Without these data, correlation between ionospheric disturbances and large earthquakes (M ≥ 7.0) occurs infrequently (~20% of events) and is within the standard error resulting from the small sample size. There are two possibilities: (1) either the mechanism of volatile (including radon) release that occurs in some regions precursory to major seismic events is unrelated to ionospheric disturbances; or (2) the occurrence of these volatiles is related first to geomagnetic and solar activity. The first hypothesis is easily falsified. In addition to careful statistical analysis by Thomas et al. and others, the mechanism for travel through the lower atmosphere of matter arising on the ground as a stable electric signal is not physically plausible. The second hypothesis awaits falsification, as the correlation fits the data. If natural events such as geomagnetic and solar activity are a trigger for large earthquakes, a plausible mechanism ought to be explored. In considering the effects of ionospheric disturbances on ground-based phenomena, geomagnetically induced currents (GIC) are a reasonable model. GIC occur generally at high latitudes and are responsible for the electrocorrosion of bridges and other metal infrastructure. Fluids laden with dissolved ions occur in faults and are a potential conduit for GIC. Electromagnetic fields induced by ionospheric anomalies may be present at depth. Can these types of fields weaken earth materials? One reason dilatancy diffusion models fell out of favor is scale. The microcracks observed are too small to hold the volume of volatiles required to account for observed changes to groundwater. If instead the presence of electric and magnetic fields aid in the liberation of volatiles and dissolution of certain minerals in rock, seismic events may occur. Andrén et al. (2016), for example, note decreasing groundwater (Si and Na) ion concentrations (ratio 2:1) as well as a small decrease in Ca and an increase in K ion concentrations during a period leading up to two consecutive M > 5 earthquakes in Hafralækur, Iceland. They took well cuttings for petrographic analysis: The observed groundwater changes are consistent with contemporary replacement of labradorite with analcime and the precipitation of zeolite minerals before and during the seismic activity, respectively, when the cuttings were taken. These observations fit the data well. In some cases, solar and geomagnetic activity cause ionospheric anomalies. These then induce electromagnetic currents in faults. The resulting fields aid in the dissolution of certain minerals and release volatiles, which are then precursory to seismic events. Groundwater changes before and after such events are related to the dissolution and subsequent precipitation of minerals in the rock. This rock weakening hypothesis fits the data, and is a simple explanation for

how correlations between ionospheric disturbances caused by solar or geomagnetic events and large seismic events may arise.